



# **The US/Global Achilles Heel: Economic Terrorism**

*DHS Advanced Scientific Computing Program*

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# Why Model Terrorist Impacts on Confidence in the Economy?

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- “We need to adopt a risk-based approach in both our operations and our philosophy. Risk management is fundamental to managing the threat, while retaining our quality of life and living in freedom.... How do we avoid becoming beguiled by the risk we have already experienced and distracted from those that our enemy might be planning in the future?” *DHS Secretary Chertoff, at George Washington University Homeland Security Policy Institute, 16 March 2005*
- “So we are continuing this policy in bleeding America to the point of bankruptcy.... every dollar of al-Qaida defeated a million dollars by the permission of Allah, besides the loss of a huge number of jobs... which is evidence of the success of the bleed-until-bankruptcy plan - with Allah's permission.” *English transcript of Usama bin Ladin's speech as published by Aljazeera, Monday, 01 November 2004*

# Current ACS Project Functions

- Model Objective:
  - Reveal how terrorist events will degrade consumer, investor, and business confidence, and cascade into broader lingering economic consequences
- Analyses:
  - Examine threats resulting in disruption to commerce & financial markets
  - Estimate economic repercussions on consumption, wealth, employment, capital expenditure, prices and jobs
  - Compare mitigation strategies to minimize economic impacts
- Model applications
  - Analyze consequences
  - Compare mitigation strategies
  - Compare response strategies
- Events & scenarios
  - Acts of terrorism
  - Contamination events
  - Disruption of trade ports
  - Natural disasters
  - Responses to biological threats
  - Trade developments & global oil market
- Identified/incorporated critical model components
  - developed broad framework of households, firms, stock & bonds markets
  - developed baselines and validation in labor and goods markets
  - current efforts add behavior and choice as agents differentiate & weigh options and cause price formation in financial markets.



# Using Models to Explore Economic Confidence

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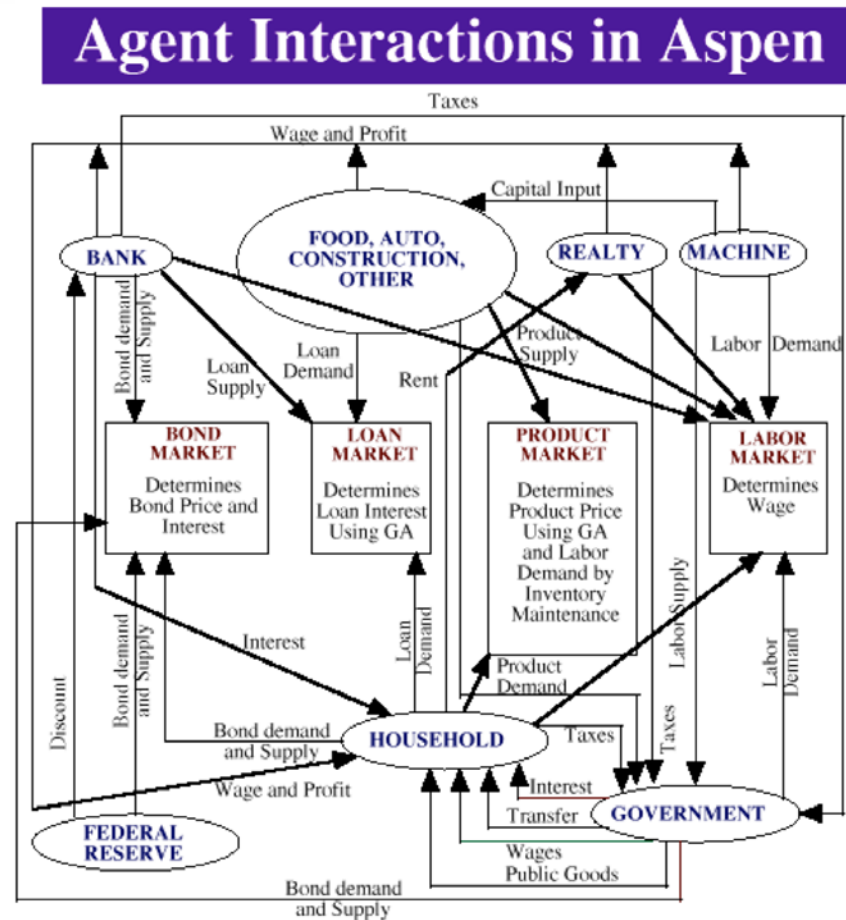
- Empirical studies indicate that consumption is more sensitive to current income than suggested under the conventional permanent income hypothesis
  - investigated expectations for future income, risk aversion, and the role of economic confidence measures.
  - surveyed body of fundamental economic literature and computational economic modeling methods to better understand cascading economic responses from terrorist threats and attacks.
- Literature survey to support incorporating economic models of confidence into agent-based microeconomic simulations.
  - reviewed underlying economic principles related to confidence dynamics.
  - reviewed the empirical studies related to economic confidence.
  - summarized efforts and publications related to agent-based economic simulation.

# The Aspen Economy Model

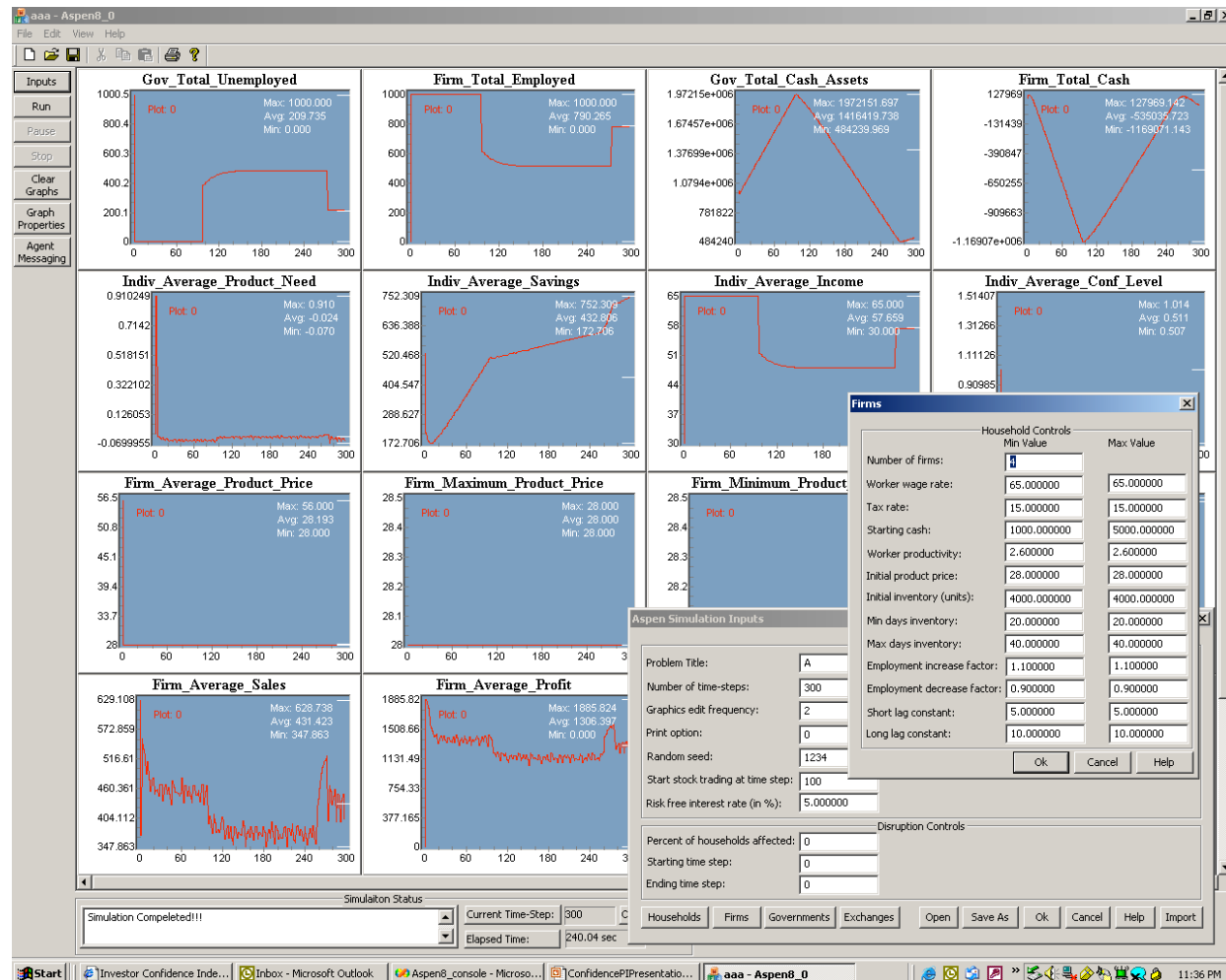
## (Starting Logic for current ASC/DHS Efforts)

### Model Elements

- Agents
- Product Markets
  - Durables, Non-durables
  - Services, Households
- Financial markets
  - Bonds, Stocks, Debt
- Decision rules
  - Consumption, Investments, & savings
  - Employment & capital
  - Expectations & forecasts
  - Confidence



# ASPEN Simulation Framework



# Basic Economic Considerations

$$\max U_{t=0} = \sum_{t=0}^{T(t)} \delta(U_t(C_t))$$

$$s.t. \sum_{t=0}^{T(t)} \rho(C_t) = B_{t=0} + \sum_{t=0}^{L(t)} \rho(Y_t),$$

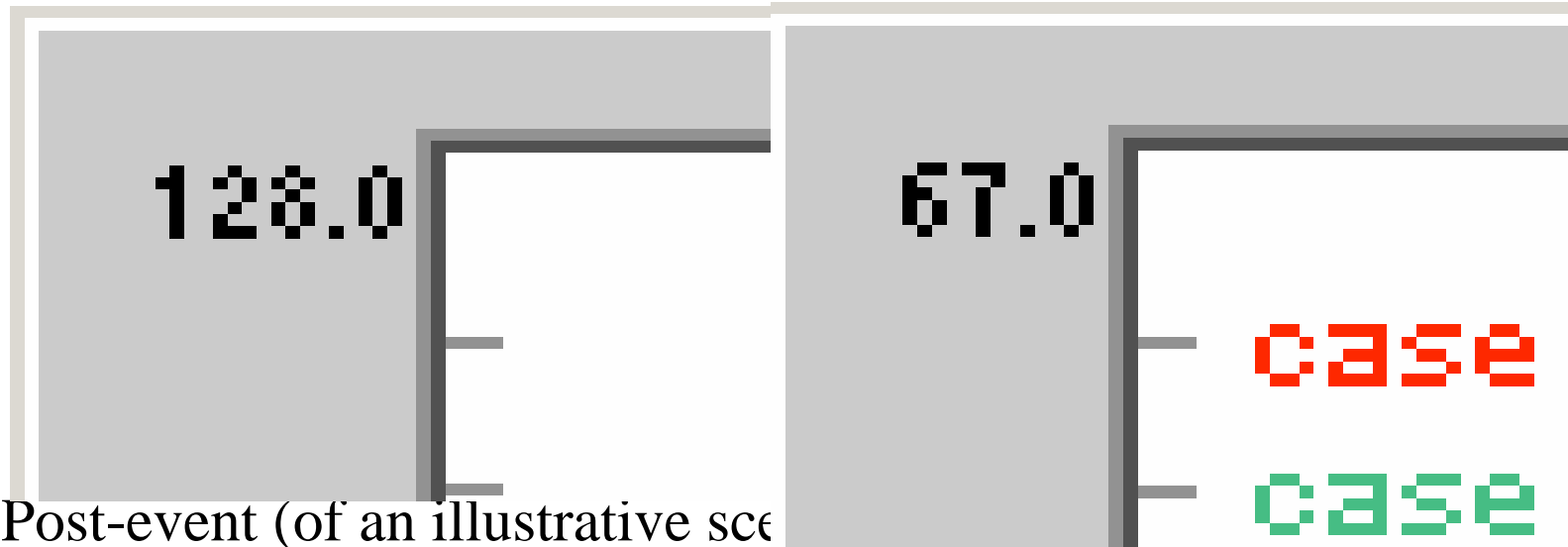
$$dU_0/dS_0 = dU_0/dS_0|_{\Psi} + \sum_i \partial U_0/\partial \psi_i \cdot \partial \psi_i/\partial S_0.$$

$$Q = Q(p^*, V_Q, V_X, L, \Psi)$$

$$L = L(p^*, V_Q, V_X, L, \Psi)$$

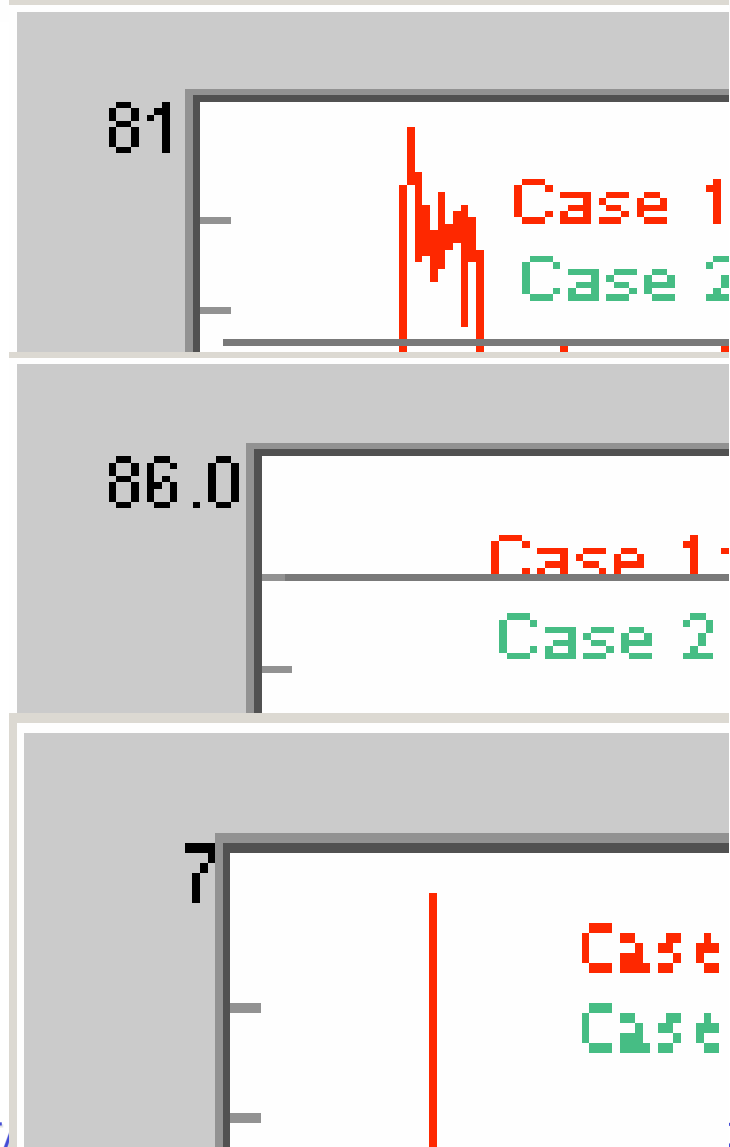
$$X = L(p^*, V_Q, V_X, L, \Psi)$$

- C is consumption
- Y is income in period t,
- U is the utility
- B is initial wealth endowment
- $\delta(\cdot)$  is the household discount rate
- $\rho(\cdot)$  is the market discount rate
- L(t) is the time left as a laborer
- T(t) is the remaining life of the household
- S is the savings rate
- A firm or household will seek to determine a level of production based upon price forecasts, upon its current inventory (V) of product (Q) and inputs (X), and upon its labor force (L), and the uncertainty and variability ( $\Psi$ ) it faces.



Post-event (of an illustrative scenario) shows an unsustained recovery followed by a prolonged slump as the loss of consumption drives business and employment in a downward spiral. The response to lost-income takes many years to recover.

**SAND04-5500: Full Employment and Competition in the Aspen Economic Model:  
Implications for Modeling Acts of Terrorism**



## Baselines for V&V and hypothesis exploration

- derived & demonstrated convergence to equilibriums and compatibility to economic theory for price/wage, employment, and consumption, in both competitive & monopoly cases
- identified emergent behavior, responses to partial information, and changes in variance



# Current Analysis Characterization

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- Not Optimization (Want to know risk ,not hopes; dynamics, not statics)
- Not Classical Econometrics or I/O Analysis (Need to robustly focus on unprecedented actions, changes, and events)
- Causal Dynamics
  - Time Delays and Feedback Dynamics
  - Psychology, Statistics, Engineering, Economics
  - Simulates actual as opposed to assumed responses
- Based on the work of 5 Nobel Prize winners
  - Bounded Rationality (Herbert Simon, 1978)
  - Qualitative Choice (Daniel McFadden, 2000)
  - Imperfect Information (Joseph Stiglitz, 2001)
  - Risk Asymmetry (Daniel Kahneman, 2002)
  - Stock and Flow Cointegration (Clive Granger, 2003)
- Detailed multi-agent representation of actual-world participants
  - Imperfect rules; Imperfect information; Imperfect (unsustainable) responses



# Summary

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- While loss of life is the operating concern of DHS, the security of the economy ultimately decides the success of the war on terrorism.
- This project focuses on mitigation, containment, response, and impact of terrorist events on the economy.
- Conventional economic methods are inadequate, but agent-based methods (Discrete Simulation) appears to uniquely capture the dynamics and emergent (human) behaviors.